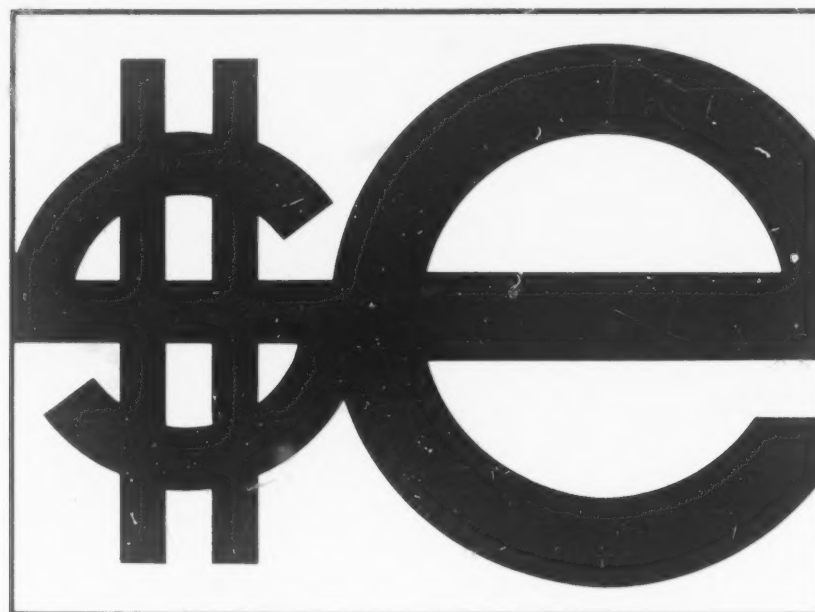


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U.S. Energy and Capital



A Forecast 1980-1990

▣ Bankers Trust Company

Foreword



Bankers Trust Company first started serving the energy industries on a specialty basis in 1948, and today our Energy Group has responsibility for handling the Bank's energy customers on a worldwide basis using a network of relationship managers, account officers and supporting specialists in Houston, London, Paris and Frankfurt as well as New York. It is the Bank's intent to offer full credit and financial services capability across the United States and around the world on a highly professional basis.

As part of this effort, the Bank began publishing in 1976 our analyses of energy policies and economics in both our periodical, *Energy Viewpoint*, and in lengthier reports such as this intended for reference use. While this study presents our own views of the domestic energy situation, it was prepared from data generated both by our staff and from external sources. It is a part of our continuing review of the energy industries' financial needs.

Our special thanks must go to numerous people at the Department of Energy, the American Petroleum Institute, the *Oil and Gas Journal*, the American Gas Association, *Electrical World* and the Edison Electric Institute who gave considerable time and thought to our ideas and requests. For their assistance and tolerance the Bank is deeply grateful. For analysis and discussion of the credit and capital markets, we must thank our Economics Department in general and Ms. Beverly Lowen in particular. In addition, our special appreciation goes to our energy economists, Dr. Herbert W. Krupp and Mr. Jacob L. Schlanger who have borne the brunt of collecting, analyzing, theorizing, rationalizing and defending the data as well as organizing and writing the report. Our associate, Mr. Richard W. Constable, has also contributed to the content of the study and the order of its language. We all offer it in the hope that our ideas and presentation will be helpful to our customers and friends as they formulate their plans for the coming years.

William E. Pelley
Senior Vice President

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Introduction



Bankers Trust Company believes that neither the Administration's oil import pledge nor the magnitude of energy investment will become a limitation on economic growth in the 1980s. The Bank reached this conclusion after having analyzed U.S. energy demand and supply requirements through 1990 and the associated capital requirements necessary to develop the domestic energy supply.

Oil import levels are forecast to remain in the 8-8.5 million-barrel-per-day range through the middle 1980s, except for the recession year of 1980, and then decline to under 6 million barrels per day by 1990. Thus the President's pledge to hold net imports to 8.5 million barrels per day is not expected to be a constraint that would be disruptive to the U.S. economy. However, the ability of the international oil market to supply the necessary imports was not part of this study, although the Bank believes that such a presumption is not unreasonable.

Capital outlays for the development of domestic energy resources are forecast to exceed one trillion dollars during the 1980-1990 period, in 1979 dollars. While this is an enormous sum, the study concludes that the U.S. economy should be able to absorb such expenditures with minimal dislocation.

Methodology

The approach taken in this study was to:

- 1) Forecast the economic environment through 1990;
- 2) Estimate energy consumption by fuel type for each consuming sector;
- 3) Project the supply of energy available from domestic sources;
- 4) Calculate the capital expenditures required to provide the projected domestic supply;
- 5) Relate the energy industries' capital expenditures to total U.S. business capital expenditures; and
- 6) Measure the impact of the energy industries' external financings on the credit and capital markets.

Assumptions

The need for energy and the ability to supply it depend on the performance of the national and world economies and on government policies. Although the unstable condition of world politics is recognized as a real threat to energy supplies in the 1980s, this study postulates that there will be no major interruptions in world energy markets. In addition to this necessary caveat, the following assumptions underlie the present study:

- 1) Real gross national product in the United States will grow at an average 2.4 percent annually through 1990, declining 0.3 percent in 1980 and rising thereafter at roughly 2.75 percent each year.
- 2) Inflation, as measured by the GNP deflator, will decline from 10.2 percent in 1980 to 8.0 percent by 1983 and remain at that level thereafter.
- 3) Rates of return within the energy industries will be high enough to support the financing necessary for the projected capital investment.
- 4) World crude oil prices in 1979 dollars will increase an average 2 to 3 percent annually. In current dollars this will bring the average price to \$90 or more per barrel by 1990.
- 5) Domestic crude oil prices will be fully decontrolled by October 1981, as now scheduled.
- 6) The price of domestic natural gas will approach BTU parity with oil in the late 1980s.
- 7) A synthetic fuels industry will be developing during the 1980s through the joint efforts of government and private industry.
- 8) Environmental protection laws and regulations will not change significantly.
- 9) Foreign sources of capital will be adequate to meet the requirements of energy development abroad.

Demand for Energy



Bankers Trust Company projects U.S. energy demand to rise over 14 percent between 1979 and 1990, from 78.2 to 89.4 quadrillion BTU (quads), excluding feedstock demand for synthetic fuels production. That is an average annual increase of 1.2 percent, less than one-third the 1964-1973 pre-embargo rate. Demand growth will be restrained by sluggish economic growth and energy-efficiency improvements resulting from higher energy prices and government conservation programs.

One measure of energy efficiency is the energy coefficient ratio, which is the ratio of the growth rate of energy use to that of the gross national product. During the ten years preceeding the 1973-1974 embargo, both energy consumption and GNP increased at roughly 4 percent per annum, giving a coefficient ratio of about one. From 1973 to 1979, however, the ratio declined to 0.3 as energy use rose only an average 0.8 percent a year and GNP growth rose 2.5 percent. (Table 1)

Table 1**GNP Growth vs. Energy Growth**

	Energy Growth (Percent)	GNP Growth (Percent)	Energy Coefficient ¹
Pre-Embargo 1963-73	4.4	4.0	1.1
Post-Embargo 1973-79	0.8	2.5	0.3
Forecast 1979-90	1.2	2.4	0.5

¹The energy coefficient represents the ratio of the percentage increase in energy consumption to the percentage increase in GNP.

Table 2**Energy Consumption Per Dollar of GNP
(Selected Years)**

	GNP (Billions of 1979 Dollars)	Energy Consumption ¹ (Quadrillion BTU)	Thousands of BTU Per Dollar of GNP
1963	1377	48.6	35.3
1973	2044	74.6	36.5
1979	2369	78.2	33.0
1980	2361	77.1	32.7
1985	2690	84.8	31.5
1990	3078	89.4	29.0

¹Excludes feedstock consumption of coal and oil shale because the derived synfuels are already included in total energy consumption.

Much of the increase in efficiency was due to simple "housekeeping" adjustments, such as resetting thermostats, turning off lights and improving equipment maintenance. Since most of these measures have already been undertaken, future improvements will become more capital intensive and difficult to achieve. Thus, the Bank's analysis indicates that the coefficient will rise to 0.5 during the forecast period, slightly higher than the post-embargo ratio, but less than one-half the pre-embargo ratio.

A major reason for the expected efficiency improvement is higher energy prices, which perhaps have soared more than most people appreciate. For example, homeowners who paid 15 to 20 cents per gallon for heating oil early in the 1970s are now paying about a dollar. Heavy fuel oil, which then cost industrial and electric utility consumers \$3.00 or so per barrel, now costs \$20 to \$30 or more, depending on quality—a 7-to 10-fold increase in less than a decade. And natural gas, for which industrial and utility customers in the pre-embargo period paid only 40 cents per cubic foot, may now cost 7 times as much. Such increases dwarf the more visible rise in gasoline prices, which have "only" tripled since 1973. While these prices are in current dollars, even after adjustment for inflation they represent enormous increases in energy costs at every level of consumption.

Bankers Trust Company believes that real prices for all forms of energy will continue to rise, and that the effects on energy consumption of past price increases have not yet fully been realized. It takes many years for the nation's energy-consuming capital stock to turn over, and as this stock is replaced, energy efficiencies will continue to improve. As a result, energy consumption per 1979-dollar of GNP, which was 36,500 BTU in 1973 and dropped to 33,000 in 1979, is expected to decline to 29,000 in 1990. (Table 2)

Energy demand data, together with supply data, are presented in Table 8 on pages 12 and 13. Data are given for the four major consuming sectors: household and commercial, industrial, transportation and electricity generation. The first three sectors include the consumption of primary fuel sources such as oil and coal, as well as electricity, which is a secondary fuel source. It should be noted that the electricity consumption figures include not only the electrical energy consumed directly in each of these sectors, but also the energy lost in generating and transmitting that electricity. The fourth consuming sector—electricity generation—accounts for all the primary power sources used to generate electricity.

Household and Commercial

Energy demand in the household and commercial sector is forecast to rise 1.7 percent annually through 1990, about equal to the rate of the late 1970s, but only one-third the pre-embargo rate. Contributing to this slower growth are first, higher energy prices, and second, a slowdown anticipated in household formation reflecting slower growth in the marriage-age population. Also important, new appliances and heating equipment will be more energy-frugal due to government-mandated efficiencies. Moreover, high home maintenance costs will encourage a movement to smaller dwellings, while government building standards will require new homes to be more energy-efficient. Finally, utility-sponsored assistance and financing of energy conservation will be encouraged, if not mandated.

In the commercial area, growth also will be far below the pre-embargo rate, but less sluggish than in the household sector, in part because the commercial sector includes the faster-growing service industries of the economy. Federal grants to schools and hospitals will encourage conservation while new federal building standards, as in the household sector, will spur efficiency improvements.

It has been assumed that all of these factors will lead to a 15 percent energy-efficiency improvement by 1990 for the average household or business unit. Two-thirds of this improvement is projected to occur by 1985, a front-loading that is meant to reflect the near-term impact of the 1979 oil-price explosion and the further hikes in gas and decontrolled domestic oil prices expected in the next few years.

Petroleum

Household and commercial use of oil is expected to slide 25 percent from 6.7 quads in 1979 to 5.0 quads in 1990. Meanwhile oil's share of the market is expected to dip from 23 percent to 14 percent. (Table 3)

Conservation accounts for part of the drop in oil consumption; homeowners and business establishments will be consuming less oil per unit. But in addition, the number of oil consumers in the residential and commercial market is projected to decline for several reasons. The doubling of oil prices in 1979-80 has hampered the oil industry's ability to compete in this market. And competitive conditions are expected to deteriorate still further, as domestic oil prices rise to the world level under the Administration's decontrol program. Moreover, gas customers in the household and commercial sector will be cushioned somewhat from rising gas prices by Federal regulations requiring that a disproportionate share of gas cost increases be passed on to industrial customers. Thus despite a growing customer base in the household and commercial market in the 1980s, the number of oil customers is expected to decline as many convert to alternative fuels, mainly gas.

Natural Gas

During much of the 1970s as natural gas supplies shrank, many gas

utilities were forced by the public utility commissions to ban new hookups. However, now that supplies have begun to stabilize and the consumption of gas in other energy-consuming sectors has been declining, supplies available to the household and commercial sector have increased. Consequently the public service commissions in most areas have lifted the hookup ban in this sector and utilities are once again soliciting new customers.

Bankers Trust Company believes that the cost of heating a home with gas will continue to be the least expensive of all fuels in most cases, and that available supplies will continue to grow for this consuming sector. As will be shown, the Bank believes the total supply of gas will remain essentially stable during the forecast period. But because the household and commercial sector will be given the highest priority in allocating whatever gas is available, natural gas consumption is projected to rise from 8.0 quads in 1979 to 8.7 quads in 1990, or 9 percent. This growth is expected despite a significant drop in gas consumption per customer.

Electricity

Consumption of electricity in the household and commercial sector is forecast to climb 45 percent from about 14.5 quads in 1979 to almost 21 quads in 1990. One reason for the growth, the Bank believes, is that electric power supplies will be perceived by many as being more reliable than oil, while in many parts of the country gas pipelines do not exist. In addition, although electricity prices will remain higher than oil or gas on a BTU basis, they will be rising less steeply. The main reason for this is that fuel costs account for only part of the cost of electric power. The remainder is for capital, materials and labor, whose costs on the whole are expected to rise less rapidly than those of energy.

Although electricity demand through 1990 will be growing more rapidly than any of the other fuels, the expected growth rate of 3.4 percent is well below the pre-embargo rate of 8.5 percent. Slower expansion of the economy, a reduction in household-formation growth, market saturation for many appliances and government-mandated efficiency standards for appliances and equipment will tend to limit gains in electricity consumption.

Industrial

Industrial demand for energy is forecast to rise only 1.6 percent annually through 1990. This growth rate is about 40 percent below that of the pre-embargo period, reflecting a slowdown in the anticipated growth of industrial activity and major improvements in energy efficiency.

Of all the fuels in the industrial market, electricity will show the fastest growth with its market share projected to rise to 42 percent by 1990, up from 34 percent in 1979 and 27 percent in 1973. Among fossil fuels, oil

Table 3**Share of Household and Commercial Market by Fuel Type
(Percent)**

	Coal	Petro- leum	Gas	Elec- tricity ¹	Other	Total
1979	0.7	22.9	27.3	49.1	—	100.0
1980	1.0	21.1	27.3	50.6	—	100.0
1985	0.9	16.8	25.5	56.2	0.6	100.0
1990	0.8	14.1	24.6	59.1	1.4	100.0

¹Includes energy conversion and transmission losses.**Table 4****Share of Industrial Market by Fuel Type
(Percent)**

	Coal	Petroleum	Gas	Electricity ¹	Total
1979	12.3	27.5	26.5	33.7	100.0
1980	12.5	25.7	27.4	34.4	100.0
1985	14.4	22.5	25.0	38.1	100.0
1990	17.3	14.2	26.6	41.9	100.0

¹Includes energy conversion and transmission losses.

use will be cut by nearly 40 percent over the decade, but this will be more than offset by a sharp rise in coal consumption and a rather substantial increase in natural gas use. (Table 4)

Industry has reduced its energy consumption by 15 percent per unit of production between 1973 and 1979, an acceleration of a trend that began even before the skyrocketing of energy prices in 1973. Most of the improvement has come from housekeeping measures. Bankers Trust Company projects energy efficiency to improve another 15 percent by 1990. Some of the projected improvements will come from additional housekeeping measures which have become economic with the 1979-80 oil price hikes. But also more capital-intensive, energy-saving projects will begin to proliferate now, spurred on by soaring domestic oil and gas prices. Many existing facilities will be overhauled to reduce energy use, and new ones will be more efficient. Government monitoring of industrial efficiency and financial incentives to improve efficiency will also play a role.

Natural Gas

Industrial consumption of natural gas is expected to climb almost 20 percent, from 7.7 quads in 1979 to 9.2 quads in 1990, with most of the increase coming after 1985. Gas will command a 27 percent share of the industrial energy market by 1990, roughly the same as in 1979. However, this is far below its 36 percent share in 1973, when consumption peaked at 10.2 quads.

In 1978 the Powerplant and Industrial Fuel Use Act was passed in response to concern that the then-existing shortage of natural gas would worsen. This act, and the associated Natural Gas Policy Act, were meant to increase the available supply of gas by increasing its price and reducing its consumption in low-priority uses. These laws prohibit industry and utilities from installing new gas-fired boilers, direct the phase-out of most such existing boilers and mandate higher prices to industrial users.

However, projections of Bankers Trust Company now indicate that total gas supplies will be adequate to meet the requirements of high-priority users and still have enough left over to meet an increase in industrial consumption. Such available gas should be allowed to be used by industrial users since it will replace imported oil. Therefore the Bank concludes that the Natural Gas Policy Act and the Fuel Use Act will be amended during the 1980s to permit greater industrial use of gas as an offset to declining oil supplies.

Coal

Bankers Trust Company expects the industrial use of coal to rise by two-thirds to 6.0 quads annually by 1990, from 3.6 quads in 1979. By 1990 coal will meet 17 percent of total industrial demand, up from 12 percent in 1979.

The predicted rise is only a recovery from more than a generation of declining use. Indeed, even though the oil embargo underscored the need to exploit this plentiful domestic resource, industrial use of coal fell by almost 20 percent between 1973 and 1979. The projected increase through 1990 would only restore consumption to the level of the mid-1950s.

Until the enormous increases in OPEC oil prices of 1979-1980, the economics were stacked heavily against any switch to coal from oil. Industrial planning was dominated by an apparent surplus of OPEC oil-producing capacity and a general feeling that oil prices would remain relatively stable, or at least not rise dramatically, through the mid-1980s. Coal's comparative cheapness was not sufficient incentive to undertake the high capital costs of conversion. New coal-fired projects cost several times as much as oil- or gas-fired ones, mainly to pay for pollution-control equipment, materials-handling facilities and storage space.

The OPEC price increases, along with the decontrol of domestic oil prices and the rise in gas prices to industry in particular, has radically changed the economics of coal conversion. On the basis of price alone, industrial use of coal in many instances is now fully justified.

Nevertheless, it is difficult to estimate how much coal consumption will actually rise in the industrial sector. On the one hand, Federal incentives, such as the supplementary tax credit, and government policies aimed at limiting industrial oil and gas use, will help increase coal consumption. On the other hand, environmental protection regulations may stand in the way, as may the continuing escalation of railroad rates for coal haulage. In any case, the potential market for coal in the industrial sector is enormous.

Electricity

Industrial use of electricity is forecast to rise 48 percent over the forecast period, from 9.8 quads in 1979 to 14.5 quads by 1990. Among all other energy sources for industry, only coal will grow at a faster rate. Annual growth of electricity use will average 3.6 percent, roughly in line with the trend since the embargo. In the pre-embargo decade industrial demand for electricity was rising 6 percent annually, but this was checked by the post-embargo economic recession and the rise of electricity prices.

In the coming decade relatively slow economic growth and more price rises will prevent growth in electricity consumption from regaining its pre-embargo growth rate. However, the projected rate is still double that of total industrial energy consumption. Several factors account for this. Electricity prices probably will not rise as fast as alternative fuels, as discussed earlier. Furthermore, security and availability

of supply will be less of a concern than for oil and gas. Finally, conversion to electric power is relatively easy and the environmental problems at the point of consumption are minimal.

Petroleum

While the use of electricity, coal and gas are projected to increase in the industrial market, the consumption of oil is forecast to slump from 8 quads in 1979 to under 5 quads in 1990, or nearly 40 percent. This represents a reversal of the post-embargo surge, when, as a replacement for dwindling gas supplies, oil consumption rose by 25 percent between 1973 and 1979.

The reasons for oil's projected decline in the industrial market—from about a 27 percent market share in 1979 to scarcely more than 14 percent in 1990—have already been discussed. These include concern about supplies from abroad, improved efficiency of energy use, availability of alternative fuels and government encouragement and pressures to switch to other fuels.

Transportation

Transportation demand for energy is expected to ease from 19.8 quads in 1979 to 19.4 in 1990—the only actual decline among the major energy-consuming sectors of the economy. By 1990 the transportation sector will be absorbing only about one-fifth of the nation's energy supply, against one-fourth of the total in 1979.

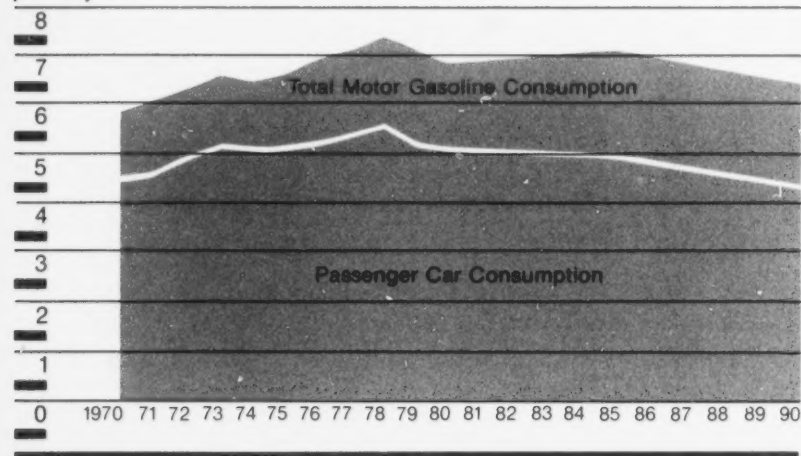
The major energy savings over the forecast period will come from a projected 25 percent decline in passenger car demand for motor fuel, virtually all of which is gasoline, and now accounts for more than half of the energy used in transportation. The year of peak demand will probably prove to have been 1978 when it was 10.3 quads, or 5.4 million barrels daily. The Bank projects annual decline rates of about 1.5 percent through 1985, and about 3 percent annually in the second half of the 1980s. (Chart 1)

There are several reasons for this decline. First, the efficiency of the average car on the road is expected to jump 55 percent by 1990, to 22.4 miles per gallon from about 14.4 in 1979, stemming from Federal fuel-economy standards, much higher gasoline prices and scrapage of older models. Second, each car is likely to be driven fewer miles each year. Finally, the growth of the passenger car fleet will probably slow to less than half the rate of the 1970s, largely because the driving-age population will be increasing less rapidly.

Motor fuel demand by small trucks, however, will continue to rise for several more years. Many drivers have been switching and, following the 1980 recession, will continue to switch to small trucks for personal use in place of automobiles. For these vehicles too, a major fuel-effici-

Chart 1
Consumption of
Motor Gasoline¹

millions of barrels
per day



¹Historic passenger car consumption has been estimated by Bankers Trust Company based on statistics obtained from Department of Energy, *Monthly Energy Review* and from Motor Vehicle Manufacturers Association, *Facts and Figures*. Projection includes some diesel fuel.

Table 5

Share of Electricity Generation by Fuel Type
(Percent)

	Coal	Petro- leum	Gas	Nuclear	Hydro	Other	Total
1979	46.9	13.6	14.8	11.5	12.8	0.4	100.0
1980	48.4	11.8	14.6	12.2	12.6	0.4	100.0
1985	49.0	8.6	9.5	20.1	11.2	1.6	100.0
1990	51.9	5.9	6.5	23.9	9.6	2.2	100.0

ency improvement is foreseen, in response to soaring fuel prices and newly-imposed government standards.

For all road vehicles, including motorcycles, passenger cars, small trucks and buses, fuel demand is expected to decline more than 10 percent by 1990 to 6.3 million barrels per day. It is expected that of this total, diesel fuel will account for a larger share of motor fuel consumption than at present.

The remainder of the transportation sector, essentially commercial transportation, includes fuel demand by large trucks, aircraft, ships and railroads and together account for about 30 percent of energy requirements in this sector. Bankers Trust Company forecasts commercial transportation demand for energy to increase, but very slowly—about 0.7 percent annually through 1990. This compares with a 3.5 percent growth rate prior to the embargo.

As in the other consuming sectors, both sluggish economic growth and higher fuel prices will contribute to the slower growth of energy demand for commercial transportation purposes. Since 1973 most attempts to conserve energy have been of the housekeeping variety such as commercial jets adding more seats, tankers slowing down and authorities raising legal shipment weights for trucks. For the future, sharply higher prices will continue to stimulate energy-efficiency improvements, but mainly through capital investments. For example, commercial jets coming on line in the 1980s will be about 50 percent more fuel efficient during take-off than existing jets.

Electricity Generation

Demand for electricity has been treated piecemeal in the preceding sections on energy consumption. In the aggregate, electricity demand is forecast to increase 3.5 percent annually through 1990, which is less than half the pre-embargo growth rate. As electric utilities increase their output, they will use less oil and gas for base-load purposes, owing both to economic factors and government policy. Coal and nuclear power will be called on to offset this reduction and supply the increased demand for electric power.

Coal

Already providing 47 percent of energy input for electric power in 1979, coal is expected to increase its share to 52 percent by 1990. Electric utility use of coal, which has risen more than one-third since the 1973 oil embargo to 11.4 quads, is forecast to climb nearly two-thirds more by 1990, to 18.5 quads. That is 20 percent more coal than is now consumed in the United States for all purposes. The Bankers Trust Company's projection is based on an analysis of scheduled additions to coal-fired generating capacity, anticipated demand for electric power and relevant government programs. (Table 5)

Many conversions to coal will be stimulated by the more rapidly rising

costs of competing fuels, but government policies will also play a leading role. These policies can be both discouraging and encouraging. Environmental policies will tend to impede the shift to coal. The Clean Air Act and state environmental regulations will prevent some construction of new coal-fired plants and some conversions from oil to coal. On the other hand, an increase in coal demand would obviously tend to follow any slowdown in nuclear power plant construction. Coal use will also get a boost from the Fuel Use Act, which prohibits new orders for oil- or gas-fired generating plants and largely prohibits the use of gas under large boilers from 1990 onward. In addition, Administration-proposed amendments to the act would hasten conversion to coal by ordering and providing funds for conversions.

Nuclear

By 1990, in Bankers Trust Company's opinion, nuclear power will be providing almost one-quarter of the nation's power requirements for electricity, or 8.5 quads. That is a tripling of the 1979 contribution of 2.8 quads, when nuclear power accounted for 12 percent of the electricity generated. However, this projected growth, based on an analysis of plants already under construction, falls far short of what would have been predicted just a few years ago.

Even before the accident at Three Mile Island in 1979, nuclear power was in serious trouble. Nuclear projects were being delayed or cancelled because of financing problems, reduced load growth, regulatory delays and environmental resistance. In addition, no nuclear plants were being ordered. Whereas in 1973, 41 new plants were ordered, by 1978 the order rate had dwindled to a single plant. And in 1979, for the first time since 1964, not one new plant was ordered. In fact, three previous orders were cancelled, and more cancellations were announced in 1980.

Nevertheless, Bankers Trust Company is convinced that nuclear power is necessary and will play an increasingly important part in the nation's energy future. Despite the ongoing controversy surrounding its development, nuclear power satisfies several needs of the United States. It has no immediate supply constraint, it is reliable, it is cost-competitive in many areas of the country and it meets operating emission and effluent standards far better than coal, the only major alternative fuel source for new base-load plants.

Petroleum

Oil use for electricity generation, squeezed between increasingly unfavorable economics and government restrictions, is forecast to drop more than 35 percent between 1979 and 1990, from 3.3 quads to 2.1 quads. By 1990 oil will provide only 6 percent of the fuel requirements of the electric utility industry, as compared with 14 percent in 1979.

The Carter Administration hopes to cut utility oil consumption even below the 2.1 quads projected by the Bank. However, the burden of such a reduction would not be spread evenly across the nation. Rather,

it would be concentrated in the Northeast and Midwest, where most of the oil-fired capacity is located, and where oil now generates 35 percent of the electric power. Environmentalist resistance to a shift to coal or nuclear power would be strong in these densely populated regions. Moreover, those utilities that now are largely reliant on oil-based generating facilities would be financially hard-pressed to convert most of their facilities to coal to meet the Administration's goal.

Natural Gas

Bankers Trust Company projects a decline of more than one-third in electric utility consumption of natural gas, to 2.3 quads in 1990 from 3.6 quads in 1979. On this basis the gas share of the utility market, which had already fallen from its peak of 24 percent in 1970 to 15 percent in 1979, would drop to less than 7 percent by 1990.

While far more drastic cutbacks had been predicted in the past, Bankers Trust Company believes that gas supplies now promise to be considerably more plentiful in the coming decade than anticipated only a few years ago. Total gas availability is expected to remain essentially flat through the coming decade, leaving significant volumes for generating electricity, even after allowing for growth in other gas-consuming sectors. As noted earlier, the Bank believes the Fuel Use Act will be amended to allow some large-boiler consumption of gas as a means of reducing oil imports.

Other

Other power sources will not contribute much to meeting the projected increase in electric power demand for the coming decade. Hydropower is expected to rise only 0.3 quad by 1990, to 3.4 quads in all. This minor increase will come from some small projects the Federal government is now encouraging, but the sites with the best potential have already been developed. Electric generation from geothermal sources, wood and waste burning will probably increase about eight-fold by 1990 to 0.8 quad, but at that level they would be furnishing only 2 percent of the utility industry's fuel requirements.

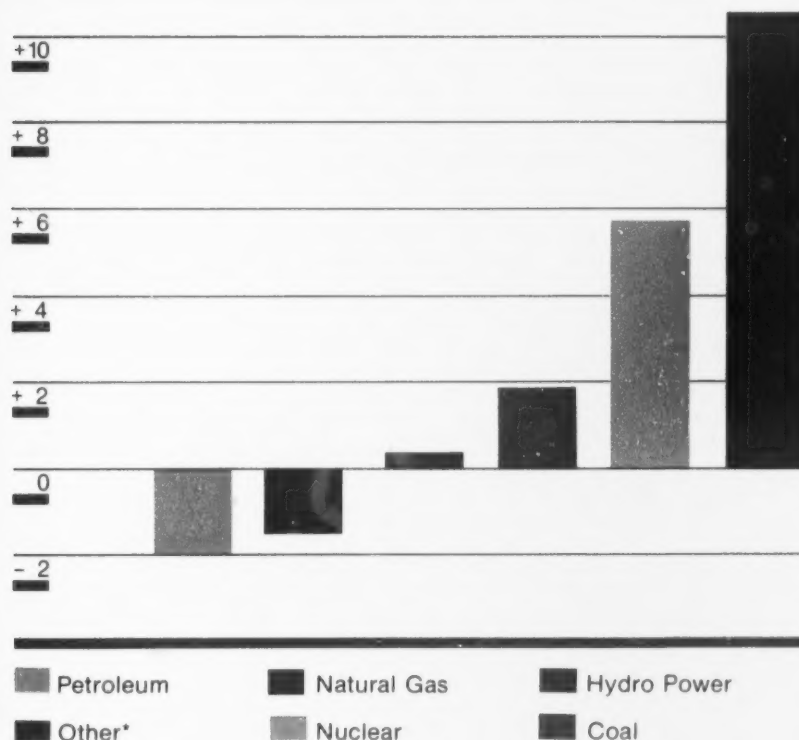
Exports

U.S. exports of energy are relatively minor. Less than 0.1 quad of natural gas is exported per annum, mainly to Japan by tanker in liquified form. Oil exports in 1979 amounted to 1.0 quad, primarily coke and petrochemical feedstocks, but also crude under an exchange agreement with Canada.

Coal is the largest U.S. energy source exported, equal to 1.7 quads in 1979, up 0.7 quad from the strike-torn year of 1978. Most exported coal is metallurgical, but recent events in the international petroleum markets have opened up new markets for steam coal. By raising freight costs considerably, the 1979-80 oil-price explosion has made U.S. coal more competitive with Australian coal in Europe. Furthermore, the

Chart 2

Changes in Domestic Energy Production 1979-1990 (Quadrillion BTU)



*Includes oil shale, geothermal, solar energy and other minor fuel sources.

growing belief that petroleum will become even more expensive and less reliable in the future will encourage greater coal conversion in the OECD countries, enlarging the potential market for steam coal. Meanwhile, given the Soviet bloc's own energy problems, the major coal-exporting nation of Poland may be forced to cut back exports in the next decade. For these reasons Bankers Trust Company foresees coal exports rising to 2.6 quads in 1990.

Supply of Energy



Since U.S. energy consumption during the next decade is projected to rise less rapidly than domestic energy production, U.S. energy imports will decline from 18.6 quads in 1979 to 15.3 quads in 1990, or by 18 percent. As a result, the foreign share of the U.S. energy supply will decline from 23 percent in 1979 to 16 percent.

Total domestic production of oil, natural gas and gas liquids, which has slumped over 10 percent between 1973 and 1979 to 39.6 quads, is expected to slide another 10 percent by 1990. Domestic oil's share of the energy supply will drop to just over one-fifth, from one-quarter now, as annual production falls from 20.4 quads in 1979 to 18.4 quads by 1990. But the expected decline in gas production within the "lower 48" states will be offset by increased imports, supplies from Alaska and synthetic gas production from coal. Thus, total gas supply is forecast to hold steady through most of the decade at about 20 quads. Since earlier projections that envisioned a steep decline in gas availability underlie most current government policies on fuels allocation, these policies are likely to be substantially modified, as has already been discussed.

Nuclear power and coal will provide virtually all the increase in the domestic supply of energy. Despite the interruption in nuclear growth following the Three Mile Island accident, nuclear power production is projected by the Bank to reach 8.5 quads in 1990, which will be nearly 11 percent of domestic energy production. At the same time coal production, which had already increased by a fourth between 1973 and 1979, is projected to jump almost two-thirds by 1990 to over 28 quads. The rise in nuclear power and coal together will be equivalent to 7.5 million barrels a day of oil. (Chart 2)

Domestic Sources

Oil and Gas

Production of oil and natural gas liquids is forecast to decline by 10 percent between 1979 and 1990 while gas production is expected to slide by 8 percent. The production decline would be much sharper were it not for two major improvements in the economic climate for domestic drilling: the doubling in 1979-1980 of world oil prices, and the easing of U.S. Government price restraints on domestic oil and gas.

World oil prices are projected to keep rising an average 2 to 3 percent per annum in real terms during the 1980s, and the regulated domestic oil price will follow suit after the price decontrol program now under-way takes full effect in October 1981. Natural gas prices will also rise substantially under the 1978 Natural Gas Policy Act.

These price increases should sharply increase the incentive and cash flow necessary for a significant rise in drilling, despite the handicap of the Crude Oil Windfall Profit Tax Act of 1980, although undoubtedly exploration and development would accelerate even more without the tax. The greatest threat to the drilling improvement remains political: an unforeseen return to price controls, or the imposition of still more burdensome taxes.

Bankers Trust Company forecasts annual footage drilled by 1990 will rise to 423 million feet, a 75 percent increase over 1979. Within this overall framework, oil drilling will probably increase somewhat faster than gas. In 1978 and 1979, 52 percent of drilling was in the oil category. However, because of the oil price increases of 1979-1980, oil's share is forecast as returning to the 57 percent level that prevailed during the 1973-1977 period.

The most accessible reserves of oil and gas in the United States have already been discovered. Thus the "finding rate"—defined as the additional reserves established per foot of drilling—can be expected to decline. Nevertheless, because of the large increase in drilling foreseen, Bankers Trust Company expects additional reserves to be established more rapidly in the 1980s than in the 1970s. By mid-decade, additions to crude oil reserves are expected to average over 2 billion barrels annually, compared to 1.3 to 1.4 billion annually in recent years. Natural gas is expected to show a similar trend, with annual additions to non-associated reserves rising to 15 trillion cubic feet per annum compared with about 10 trillion in recent years.

Although annual additions to reserves will be rising in the 1980s, they will still fall short of annual production. The inevitable result is that production itself will continue to slide through the middle 1980s, though not nearly as fast as if drilling were not to increase.

Historically, U.S. crude oil production has dropped from a peak of 9.6 million barrels daily in 1971 to about 8.5 million in 1979, which is equal to 3.1 billion barrels annually. Bankers Trust Company expects production to slide to some 7.5 million barrels daily by 1985 and remain essentially flat through 1990. Including natural gas liquids, total liquid hydrocarbon production is seen dropping from 10.2 million barrels daily in 1979 to 9.1 million in 1985 and 1990, or from about 3.7 to 3.3 billion barrels annually. Thus by 1990 the oil share of domestic energy production will have declined to 23.5 percent from 32.2 percent in 1979. (Tables 6 and 7)

Similarly, natural gas output, which peaked at more than 21.5 trillion cubic feet annually in 1971-1973 and has since slumped to 18.8 trillion, is expected to taper to 16.5 trillion by 1985. During the middle to late 1980s, the introduction of Alaskan gas will add 0.9 trillion cubic feet a year to

Table 6

Energy Supply in Conventional Units¹
(Major Energy Sources)

	Domestic					Foreign	
	Coal ² (Millions of Tons)	Petro- leum ³ (Billions of Barrels)	Gas ⁴ (Trillions of Cubic Feet)	Nuclear ⁵ (Billions of KWHRS)	Hydro ⁶ (Billions of KWHRS)	Petro- leum ⁷ (Billions of Barrels)	Gas ⁴ (Trillions of Cubic Feet)
1979	776	3.7	18.8	256	279	3.0	1.2
1980	780	3.7	18.2	279	279	2.8	1.4
1985	1000	3.3	16.5	566	306	3.1	2.7
1990	1290	3.3	17.2	789	306	2.2	2.7

¹Conversion factors used are from DOE, *Monthly Energy Review*.

²Because relatively low-BTU Western coal will increase more rapidly than Eastern coal, average BTU per ton of coal are projected to drop from 22.8 million in 1979 to 22.0 million in 1990.

³Based on 5.55 million BTU per barrel of domestic production, which includes crude oil and natural gas liquids.

⁴Based on 1,021 BTU per cubic foot.

⁵Based on 10,769 BTU per KWHR.

⁶Based on 10,435 BTU per KWHR.

⁷Based on 5.8 million BTU per barrel of imported oil.

Table 7

Share of Domestic Primary Production
(Percent)

	Coal	Petro- leum	Gas	Nuclear	Hydro	Other ¹	Total
1979	28.1	32.2	30.3	4.4	4.9	0.1	100.0
1980	28.5	32.1	29.6	4.8	4.9	0.1	100.0
1985	32.9	27.1	24.8	9.0	5.0	1.2	100.0
1990	36.3	23.5	22.5	10.9	4.3	2.5	100.0

¹Includes oil shale, geothermal, solar energy and other minor fuel sources.

total U.S. production, more than offsetting the slight decline forecast for lower 48 production during this period. Thus natural gas production in 1990 will amount to 17.2 trillion cubic feet, up 0.7 trillion from 1985.

Coal

Coal production in the United States is restrained principally by insufficient demand rather than limited supply, and demand in the future will be heavily influenced by government and regulatory agencies. As demonstrated earlier, substantially increased coal consumption by industrial and electric utility users is inevitable in the 1980s. However, the Bank feels that consumption of coal will not realize its full potential, in large part because of restrictive regulations relating to mining operations and air pollution control which affect both the cost of producing and using coal. Despite these restraints, Bankers Trust Company forecasts U.S. coal production to grow at an average annual rate of 4.7 percent, from 776 million tons per year in 1979 to 1,290 million tons per year in 1990.

At the present time excess producing capacity may be as much as 100 million tons per year, much of it developed in response to earlier optimistic forecasts for coal orders that did not materialize. This surplus capacity, much of it in the West, will reduce the need for new development through 1985. By then much of the excess will probably be eliminated, and an acceleration of mine development will begin. Bankers Trust Company projects western coal production to increase from under 200 million tons in 1979 to 335 million tons in 1985 and 505 million tons in 1990. Because the effect of the surface-mining regulations on eastern coal will be more costly, surface-mined production there is forecast to increase only 1.4 percent per annum, from about 275 million tons per year in 1979 to 320 million tons in 1990. Deep-mined coal production in the East will expand at about 3.8 percent from 310 to 465 million tons in the same period. At these rates of growth no serious difficulties are expected to develop in providing necessary mining equipment or additional personnel.

Synthetic Fuels

The synthetic fuels industry is considered in this study to include those manufacturing and extraction processes which produce fuels from coal, oil shale, tar sands and biomass. These processes are currently in varying stages of research and development, and large and important energy sources should evolve before the end of the century. However, the programs required to get commercial enterprises started will move slowly and Bankers Trust Company believes that no major synfuel contribution to U.S. energy supply can be expected until after 1990.

Even though the economic viability of synfuels has been significantly improved by the increase in world crude prices in 1979, there is little chance that the Carter Administration's stated goal for synfuels production of 1.75 million barrels of oil-equivalent daily by 1990 can be achieved on schedule.

The obstacles to reaching the goal on time are numerous. As of early 1980 there is not a single commercial-scale synfuel plant in operation in the United States. Much development work needs yet to be done to bridge the gap from pilot and demonstration projects to full-scale commercial plants. Another obstacle is the long lead times anticipated, which mean long-term capital burdens as well as additional market risks. Design, licensing and construction of a commercial-scale plant will probably average six years, though the interval could conceivably be shortened a bit. Still another obstacle is the sheer magnitude of costs which are disproportionately large for the size of the resulting production.

Even if the financing obstacles are overcome, it is doubtful that the engineering and construction industry could gear up fast enough to meet the Administration target. Synfuel plants would be competing with conventional industries for a wide range of components—heat exchangers, boilers, valves and so on—as well as for engineers. Availability of these components and the necessary manpower could prove to be a definite constraint.

Formidable environmental obstacles must also be overcome. Synfuel plants will unavoidably produce airborne emissions, fluid effluents and solid wastes. Furthermore, since the plants will require large volumes of water and most potential coal and oil-shale feedstocks lie in semi-arid regions, water supplies will be crucial. And ethanol production for gasohol will be constrained by the availability of the biomass feedstock and ultimately by unattractive economics.

Finally, there is the obstacle of government regulation, which has done much to hinder synfuels development in the past through tortuously slow licensing and permitting procedures. Some relief may have been provided by the Energy Mobilization Board, whose mission would have been to reduce unreasonable delays in licensing major energy projects. But some critics believe that the EMB, even if eventually passed, will just add another layer of bureaucracy.

Bearing in mind these many obstacles to the rapid development of synthetic fuels, the Bankers Trust Company forecast limits synfuel production to 500,000 barrels per day of oil equivalent by 1990, less than one-third the target set by the Administration.

Other

Solar energy, geothermal and wind power are regarded as highly desirable by the public and many experts. They have the advantages of being domestically available, renewable and environmentally sound in many instances. While research and development work is proceeding on these forms of energy, and some application of them is being made today in a variety of processes and locales, Bankers Trust Company doubts that they will make more than a small contribution to the nation's energy supply by 1990. While these and other renewable energy sources, such as nuclear fusion, may be significant in the twenty-first century,

together they will provide less than one quad of energy in 1990.

Although wood is not directly included in official energy statistics or in this study, it is estimated to provide 1.8 to 2.0 quads of energy in the United States. Because official statistics fail to record wood consumption as it replaced some fossil fuels in recent years, the degree of conservation in the United States is somewhat overstated. At present, over 1 quad is used by the paper and forest products industries and around 0.6 quad is consumed by the residential sector. According to some estimates, wood has an annual potential of 9 quads.

Foreign Sources

Oil

Oil imports are expected to decline nearly 30 percent by 1990, to 5.9 million barrels daily, from 8.2 million barrels in 1979. A temporary drop in 1980 to about 7.5 million barrels daily, reflecting the immediate impact of the OPEC price explosion and the U.S. economic recession, will probably give way to a rise in imports to over 8 million barrels daily for 1981 and roughly 8.5 million through the middle 1980s. Then a declining trend is expected to begin, bringing the necessary import level to under 6 million barrels per day by 1990.

In the Bankers Trust Company forecast, oil imports have been used to make up the difference between U.S. energy demand and all other energy sources. Its projection on this basis indicates that the 1979 Tokyo Agreement to limit oil imports will not act as a constraint on U.S. energy consumption. Although Bankers Trust Company believes that world supply is likely to support this import level, analysis of international supply and markets is beyond the scope of this study. (Chart 3)

Gas

Natural gas imports, via pipeline from Mexico and Canada and via tanker in the form of liquefied natural gas (LNG), are projected as rising from 1.2 trillion cubic feet in 1979 to 2.7 trillion cubic feet in 1990. Gas from Canada is expected to increase from less than 1 trillion cubic feet in 1979 to 1.8 trillion cubic feet in 1982, as Canadian gas is fed into "pre-built" sections of the Alaskan gas pipeline. But as Alaskan gas starts flowing after 1985, Canadian input will fall back to about 1.0 trillion cubic feet by 1990. Meanwhile, imports from Mexico, which have started up only recently and totalled only 0.1 trillion cubic feet in 1979, are expected to rise to 0.4 trillion cubic feet by 1990. LNG imports will more than quadruple to nearly 1.2 quads per year by 1985, but will then level off as presently licensed projects are completed.

Chart 3

U.S. Petroleum Supply

millions of barrels
per day

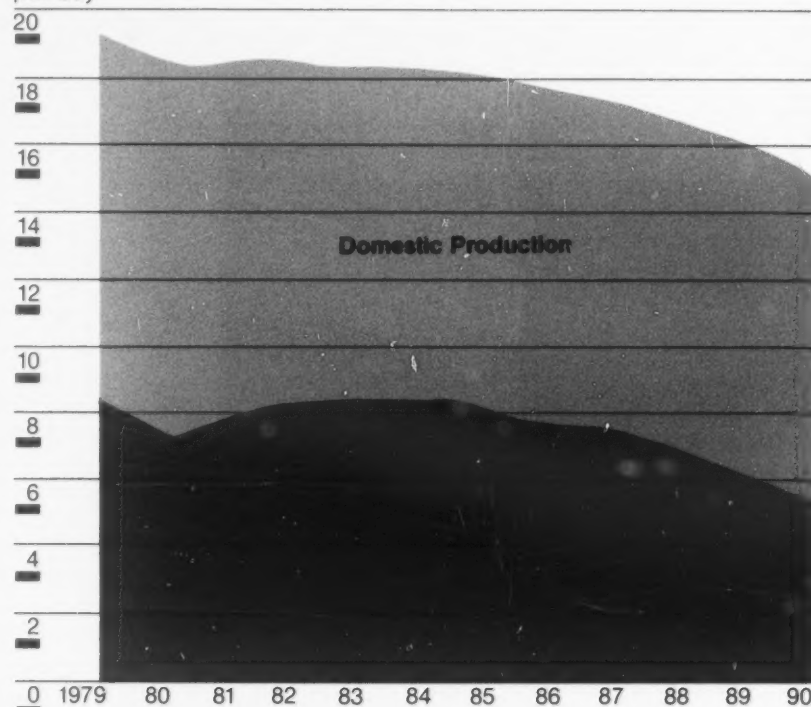


Table 8¹**U.S. Energy Demand and Supply 1979²**
(Quadrillion BTU)

	Coal	Petroleum	Gas	Shale	Nuclear	Hydro	Other	Electricity ³	Total
Demand									
Domestic									
Household & Commercial	0.2	6.7	8.0	—	—	—	—	14.4	29.3
Industrial	3.6	8.0	7.7	—	—	—	—	9.8	29.1
Transportation	—	19.2	0.5	—	—	—	—	0.1	19.8
Electricity Generation	11.4	3.3	3.6	—	2.8	3.1	0.1	(24.3) ⁴	—
Synfuel Feedstock ⁵	—	—	—	—	—	—	—	—	—
Total Domestic	15.2	37.2	19.8	—	2.8	3.1	0.1	—	78.2
Exports	1.7	1.0	0.1	—	—	—	—	—	2.8
Total Demand	16.9	38.2	19.9	—	2.8	3.1	0.1	—	81.0
Supply									
Domestic									
Primary	17.8	20.4	19.2	—	2.8	3.1	0.1	—	63.4
Synthetic Fuels ⁶	—	—	—	—	—	—	—	—	—
Total Domestic	17.8	20.4	19.2	—	2.8	3.1	0.1	—	63.4
Imports	—	17.4	1.2	—	—	—	—	—	18.6
Adjustment ⁷	(0.9)	0.4	(0.5)	—	—	—	—	—	(1.0)
Total Supply	16.9	38.2	19.9	—	2.8	3.1	0.1	—	81.0

1980

	Coal	Petroleum	Gas	Shale	Nuclear	Hydro	Other	Electricity ³	Total
Demand									
Domestic									
Household & Commercial	0.3	6.1	7.9	—	—	—	—	14.6	28.9
Industrial	3.6	7.4	7.9	—	—	—	—	9.9	28.8
Transportation	—	18.8	0.5	—	—	—	—	0.1	19.4
Electricity Generation	11.9	2.9	3.6	—	3.0	3.1	0.1	(24.6) ⁴	—
Synfuel Feedstock ⁵	—	—	—	—	—	—	—	—	—
Total Domestic	15.8	35.2	19.9	—	3.0	3.1	0.1	—	77.1
Exports	1.9	1.0	0.1	—	—	—	—	—	3.0
Total Demand	17.7	36.2	20.0	—	3.0	3.1	0.1	—	80.1
Supply									
Domestic									
Primary	17.9	20.2	18.6	—	3.0	3.1	0.1	—	62.9
Synthetic Fuels ⁶	—	—	—	—	—	—	—	—	—
Total Domestic	17.9	20.2	18.6	—	3.0	3.1	0.1	—	62.9
Imports	—	16.0	1.4	—	—	—	—	—	17.4
Adjustment ⁷	(0.2)	—	—	—	—	—	—	—	(0.2)
Total Supply	17.7	36.2	20.0	—	3.0	3.1	0.1	—	80.1

¹See footnotes on page 14

1985

	Coal	Petroleum	Gas	Shale	Nuclear	Hydro	Other	Electricity ³	Total
Demand									
Domestic									
Household & Commercial	0.3	5.4	8.2	—	—	—	0.2	18.1	32.2
Industrial	4.6	7.2	8.0	—	—	—	—	12.2	32.0
Transportation	—	20.0	0.5	—	—	—	—	0.1	20.6
Electricity Generation	14.9	2.6	2.9	—	6.1	3.4	0.5	(30.4) ⁴	—
Synfuel Feedstock ⁵	0.2	—	—	0.1	—	—	—	—	0.3
Total Domestic	20.0	35.2	19.6	0.1	6.1	3.4	0.7	—	85.1
Exports	2.3	1.0	—	—	—	—	—	—	3.3
Total Demand	22.3	36.2	19.6	0.1	6.1	3.4	0.7	—	88.4
Supply									
Domestic									
Primary	22.3	18.4	16.8	0.1	6.1	3.4	0.7	—	67.8
Synthetic Fuels ⁶	—	0.1	0.1	—	—	—	—	—	0.2
Total Domestic	22.3	18.5	16.9	0.1	6.1	3.4	0.7	—	68.0
Imports	—	17.7	2.7	—	—	—	—	—	20.4
Total Supply	22.3	36.2	19.6	0.1	6.1	3.4	0.7	—	88.4

1990

	Coal	Petroleum	Gas	Shale	Nuclear	Hydro	Other	Electricity ³	Total
Demand									
Domestic									
Household & Commercial	0.3	5.0	8.7	—	—	—	0.5	20.9	35.4
Industrial	6.0	4.9	9.2	—	—	—	—	14.5	34.6
Transportation	—	18.7	0.5	—	—	—	—	0.2	19.4
Electricity Generation	18.5	2.1	2.3	—	8.5	3.4	0.8	(35.6) ⁴	—
Synfuel Feedstock ⁵	1.0	—	—	0.7	—	—	—	—	1.7
Total Domestic	25.8	30.7	20.7	0.7	8.5	3.4	1.3	—	91.1
Exports	2.6	1.0	—	—	—	—	—	—	3.6
Total Demand	28.4	31.7	20.7	0.7	8.5	3.4	1.3	—	94.7
Supply									
Domestic									
Primary	28.4	18.4	17.6	0.7	8.5	3.4	1.3	—	78.3
Synthetic Fuels ⁶	—	0.7	0.4	—	—	—	—	—	1.1
Total Domestic	28.4	19.1	18.0	0.7	8.5	3.4	1.3	—	79.4
Imports	—	12.6	2.7	—	—	—	—	—	15.3
Total Supply	28.4	31.7	20.7	0.7	8.5	3.4	1.3	—	94.7

footnotes for table 8

²Data for 1979 and energy conversion factors are from *Monthly Energy Review*, Department of Energy, March, 1980.

³Includes energy lost in the generation and transmission of electricity, which accounts for more than two-thirds of the figures shown in this column.

⁴To avoid double counting, energy consumed for electricity generation is netted out of total energy demand, since electricity is already accounted for in the household and commercial, industrial and transportation sectors shown above.

⁵Represents the demand for coal and oil shale as a feedstock for synfuels production. About one-third of the energy feedstock is lost in the conversion process.

⁶Represents the supply of synthetic oil and gas derived from coal and oil shale feedstocks.

⁷Represents adjustments necessary to balance demand and supply, which include inventory changes, losses, gains and unaccounted for supply.

Table 9

Inflation and Cost Increase Assumptions

Sector	Time Period	Increase Per Annum (Percent)
General Economy		
GNP Deflator	1980	10.2%
	1981	9.1
	1982	8.5
	1983-90	8.0
Energy¹		
Oil & Gas E&P and Petroleum Refining	1980-82	2% + Deflator
	1983-85	1 + Deflator
	1986-90	Deflator
Gas Utility and Pipelines	1980-85	2 + Deflator
	1986-90	Deflator
Electric Utility	1980-90	1 + Deflator
All Other Energy Sectors	1980-90	Deflator

¹These represent cost increases associated with particular energy sectors in addition to the general inflation rate, as measured by the GNP deflator. These additional cost increases are expected to result from demand-pull inflation, true cost increases such as those associated with drilling in more hostile areas, and government-induced increases resulting from more stringent safety or environmental standards. Although the incremental-cost assumptions are somewhat arbitrary, the Bank believes that they are more indicative of future energy cost trends than the GNP deflator alone.

Capital Requirements for Plant and Equipment



Having estimated domestic energy requirements in the previous section, this section projects the associated expenditures necessary to develop the supply. Spending for fixed plant and equipment is expected to reach \$297 billion in 1990, up from roughly \$79 billion in 1979.

Use of such current-dollar figures during a highly inflationary period, however, seriously distorts the underlying economic trends. For instance, inflation actually accounts for 80 percent of the current-dollar spending increase projected between 1979 and 1990. Therefore, to evaluate better the year-to-year changes, all economic analyses and tables in this section are presented in 1979 dollars.

In developing these constant-dollar projections, Bankers Trust Company recognizes that demand-pull inflation and other factors peculiar to the energy industries have been escalating many unit costs at rates above general inflation. To account for these forces, the Bank has computed a series of cost-escalation indices for the various energy industries. These indices were applied to present unit costs to determine true future unit costs, which were then used to estimate total capital costs in 1979 dollars. (Table 9)

For the 1980-1990 period total expenditures, in 1979 dollars, for the energy industries are forecast to exceed \$1.1 trillion. Per annum expenditures by 1990 are projected to rise to \$123 billion—up from \$37 billion in 1973. Thus the nation will be spending 3½ times more for energy development in 1990 than in 1973, but it will be producing only 25 percent more energy. (Expenditures in current and constant dollars are presented in Tables 10 and 11, respectively.)

Within the energy sector, expenditures for oil and gas will rise from about 43 percent of total capital outlays in 1979 to 46 percent by 1990, with the exploration and development share rising from 36 percent to 41 percent and the downstream sectors declining from about 7 percent to 5 percent. By 1990 expenditures for alternative fuels will claim almost one out of every \$10 of energy investment, up from almost nothing in 1979. Although coal expenditures will increase significantly by 1990, they will still account for less than 4 percent of all energy outlays. Meanwhile the electric utility industry's share, including outlays for the nuclear fuel cycle, will fall from about 47 percent in 1979 to 36 percent in 1990. (Chart 4)

Oil and Gas Industry

Exploration and Development

Expenditures for oil and gas exploration and development, including leasing costs, are forecast to rise from \$28.6 billion in 1979 to \$51.1 billion in 1990, or by nearly 80 percent. These expenditure estimates were obtained by applying expected costs per foot to the projected footage drilled per annum. Per-foot estimates were based on average costs of recent years, converted to 1979 dollars.

Historically, the nearly two decades of decline in drilling ended in 1971, when footage began to rise again in response to higher gas prices in the uncontrolled intrastate markets. By 1979, with soaring crude oil prices and improved interstate gas prices, footage had increased 90 percent above the 1971 level to about 240 million feet. This slightly exceeded the previous record set in 1956, when the oil and gas requirements of the nation were much smaller. However, because the average depth per well had increased, the number of wells drilled in 1979 was still below that of 1956.

As stated in the oil and gas supply section, footage drilled is projected to rise to 423 million feet by 1990, about 75 percent above 1979. An increase of 10 percent is expected in 1980, which will taper off to, and plateau at, 3 percent annually by 1987. The initial surge may strain, but probably not over-tax, the capabilities of the drilling industry and the manufacturers who supply it.

Leasing expenditures are highly dependent on government leasing schedules, bidding methods and the cash flow position of the bidders. Since it is impossible to predict these variables with any degree of accuracy, Bankers Trust Company has estimated leasing costs by relating them to other drilling costs. Based on the post-embargo proportion of leasing costs to exploration and development costs of 13 percent, leasing expenditures are forecast to rise from \$4.6 billion in 1979 and an expected \$3.0 billion in 1980 to almost \$6.0 billion in 1990.

Refining

Though overall U.S. demand for oil products will stabilize and then decline in the 1980s, annual refining capital requirements will be rising for the next few years. From \$2.7 billion in 1979, they are expected to peak at \$4.8 billion in 1982 and then decline until the late 1980s, when expenditures once again begin rising.

In contrast to earlier periods, very little future investment will go to expanding capacity, though at least one major new refinery will be built on the East Coast. Rather, investment for the next few years will focus on the adaptation of existing capacity to changes in the crude oil supply and refined product slates. As refiners are forced to shift increasingly to heavier and more sulfurous grades of crude in the 1980s, additional investment in desulfurization and catalytic cracking equipment will be required. The rise in expenditures forecast to occur late in the

decade will result from the industry's investment in specialized equipment needed for refining the output of a growing synfuels industry.

Transportation

Annual investment in oil transportation is expected to rise from \$1.9 billion in 1979 to \$2.5 billion in 1982 and then decline to \$1.7 billion by 1990. In the main, this reflects the anticipated decline in oil consumption. Apart from a few large projects in the early 1980s, most pipeline investment will be for maintenance of the existing network. Because of the expected decline in oil consumption, total shipping tonnage will not increase and most tanker expenditures will be for the replacement of the over-age U.S. tanker fleet, 43 percent of which is over 15 years old.

Investment levels will be buoyed in the near term by work on two major projects: The Louisiana Offshore Oil Port (LOOP) scheduled to become operational in 1981 and the Northern Tier Pipeline to carry Alaskan crude from Port Angeles, Washington to the Midwest. In early 1980 Northern Tier had not yet received all the necessary permits, but the Bank projects that the great bulk of the required investment for this or an alternative project will be completed by the end of 1983.

Marketing

Because most oil marketing investment relates to gasoline and home heating oil sales, both of which are contracting, capital investment over the decade will also be shrinking. This represents a continuation of the post-embargo trend. In 1972 there were 226,000 gasoline service stations in the United States and industry invested more than \$1.8 billion for marketing. By 1979 the number of service stations had dropped 27 percent, while marketing investment had declined by 45 percent to \$1.0 billion.

Although investment in 1980 is expected to rise by 20 percent, Bankers Trust Company expects that by 1983 it will have slipped back to the level of 1979. The initial surge reflects the industry's effort to replace many marginal low-volume filling stations with fewer high-volume ones, convert full-service to self-service stations, upgrade existing facilities and adapt stations to meet various environmental regulations. By 1990 investment probably will have dropped 60 percent from 1979 to about \$400 million.

Alternative Fuels

Based on an alternative fuels production level of 500,000 barrels per day of oil equivalent, Bankers Trust Company forecasts cumulative outlays in the 1980-1990 period of nearly \$46 billion. Included within this figure are relatively minor outlays for solar and other renewable energy sources. With project lead times averaging six years, most of the \$11.2 billion expenditure in 1990, as well as a large portion of previous years' expenditures, will be for projects that come on stream after 1990.

Table 10
Fixed Capital Requirements for the Energy Industries
 (Billions of Current Dollars)

Energy Industries	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1980-90
Oil and Gas													
Exploration and Development	28.6	33.5	38.8	46.4	54.0	62.7	71.8	80.6	89.7	99.8	111.0	123.4	811.7
Refining	2.7	3.9	5.0	6.2	6.2	6.2	6.2	6.2	6.7	7.2	8.4	9.7	71.9
Marketing	1.0	1.3	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.1	1.0	13.9
Transportation ²	1.9	2.2	2.7	3.3	3.1	3.0	3.5	3.6	3.7	3.9	4.0	4.2	37.2
Total	34.2¹	40.9	47.9	57.3	64.7	73.2	82.8	91.7	101.3	112.1	124.5	138.3	934.7
Alternative Fuels³	0.3⁵	0.5	1.0	1.5	2.3	3.8	5.5	7.5	10.0	12.9	18.9	26.9	90.8
Coal													
Mining	2.1 ⁴	2.1	2.0	2.4	2.7	3.3	4.1	4.5	5.1	5.9	6.7	7.7	46.5
Transportation	1.4 ⁵	1.5	1.7	1.8	2.0	2.2	2.5	2.9	3.4	3.8	4.4	5.2	31.4
Total	3.5	3.6	3.7	4.2	4.7	5.5	6.6	7.4	8.5	9.7	11.1	12.9	77.9
Electric Utility													
Generation	24.9	24.8	26.7	28.7	30.1	32.2	37.4	43.3	48.5	54.3	60.8	67.5	454.3
Transmission, Distribution & Related Facilities	10.4	10.5	11.3	12.2	12.8	13.7	15.8	18.4	20.6	23.0	25.8	28.6	192.7
Total	35.3⁶	35.3	38.0	40.9	42.9	45.9	53.2	61.7	69.1	77.3	86.6	96.1	647.0
Nuclear Fuel Cycle	1.9⁵	2.4	3.0	3.9	4.7	5.4	6.1	7.1	8.4	9.4	10.7	12.2	73.3
Gas Utility	4.2⁷	5.2	7.8	9.5	11.4	18.1	16.1	8.0	8.6	9.3	10.1	10.9	115.0
Total Energy Industries	79.4	87.9	101.4	117.3	130.7	151.9	170.3	183.4	205.9	230.7	261.9	297.3	1938.7

¹*Oil & Gas Journal*, February 18, 1980. Exploration and development data have been modified slightly to include gas utility expenditures as estimated in *Gas Facts*, 1978, American Gas Association.

²The transportation section includes expenditures for crude and product pipelines, deepwater ports and tankers.

³Primarily synthetic fuel expenditures, with relatively minor outlays for solar energy.

⁴McGraw Hill capital spending survey.

⁵Bankers Trust Company estimate.

⁶*Electrical World*, March 15, 1980.

⁷Estimated by American Gas Association, *Gas Facts*, 1978.

Table 11¹**Fixed Capital Requirements for the Energy Industries**
(Billions of 1979 Dollars)

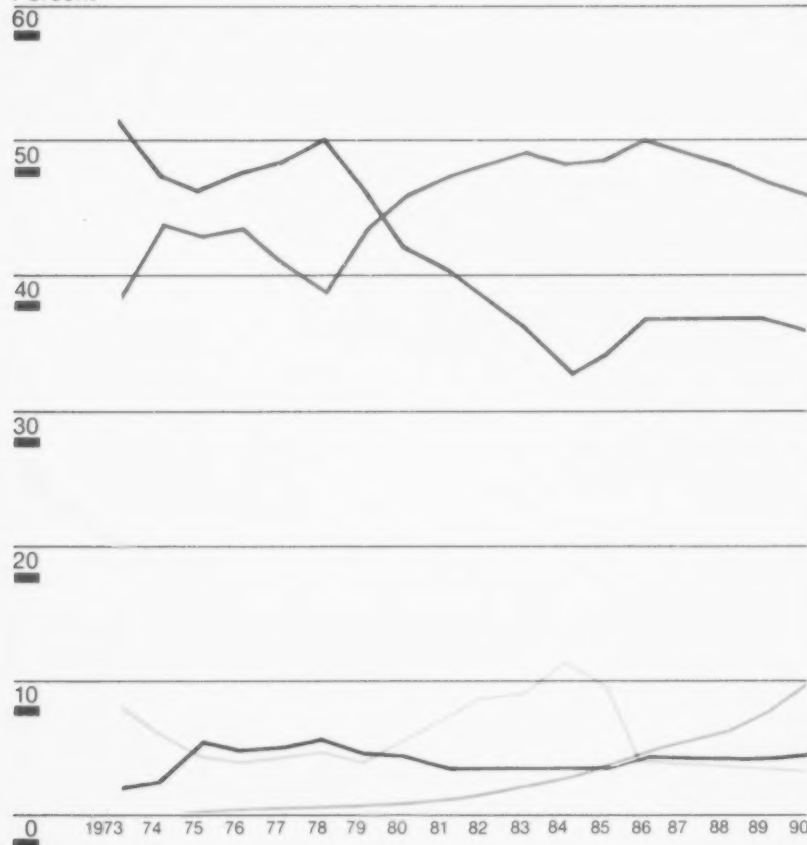
Energy Industries	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1980-90
Oil and Gas													
Exploration and Development	28.6	30.4	32.3	35.6	38.3	41.2	43.7	45.4	46.8	48.2	49.6	51.1	462.6
Refining	2.7	3.6	4.2	4.8	4.4	4.1	3.8	3.5	3.5	3.5	3.8	4.0	43.2
Marketing	1.0	1.2	1.1	1.0	1.0	0.9	0.8	0.7	0.6	0.6	0.5	0.4	8.8
Transportation	1.9	2.0	2.3	2.5	2.2	2.0	2.1	2.0	2.0	1.9	1.8	1.7	22.5
Total	34.2	37.2	39.9	43.9	45.9	48.2	50.4	51.6	52.9	54.2	55.7	57.2	537.1
Alternative Fuels	0.3	0.5	0.8	1.2	1.7	2.5	3.3	4.2	5.2	6.5	8.5	11.2	45.6
Coal													
Mining	2.1	1.9	1.7	1.8	1.9	2.2	2.5	2.5	2.6	2.9	3.0	3.2	26.2
Transportation	1.4	1.4	1.4	1.4	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	18.3
Total	3.5	3.3	3.1	3.2	3.3	3.7	4.1	4.2	4.4	4.8	5.0	5.4	44.5
Electric Utility													
Generation	24.9	22.5	22.2	22.0	21.4	21.2	22.7	24.4	25.3	26.2	27.2	28.0	263.1
Transmission, Distribution & Related Facilities	10.4	9.5	9.4	9.3	9.1	9.0	9.6	10.3	10.7	11.1	11.5	11.9	111.4
Total	35.3	32.0	31.6	31.3	30.5	30.2	32.3	34.7	36.0	37.3	38.7	39.9	374.5
Nuclear Fuel Cycle	1.9	2.2	2.5	3.0	3.4	3.5	3.7	4.0	4.4	4.5	4.8	5.1	41.1
Gas Utility	4.2	4.8	6.5	7.3	8.1	11.9	9.9	4.5	4.5	4.5	4.5	4.5	71.0
Total Energy Industries	79.4	80.0	84.4	89.9	92.9	100.0	103.7	103.2	107.4	111.8	117.2	123.3	1113.8

¹See Table 10 for footnotes.

Chart 4

Share of Total Energy Expenditures by Industry

Percent



Oil and Gas Alternatives Gas Utility
Electric Utility and Nuclear Fuel Cycle Coal

These estimates assume a capital cost of \$45,000 per daily barrel oil equivalent. This compares to recent estimates of \$20,000 to \$30,000 per daily barrel for shale oil, \$60,000 to \$70,000 for coal liquefaction, and a figure somewhere between these extremes for synthetic gas. It must be emphasized that such estimates are highly speculative, because no commercial-scale synfuel plants have yet been built in the United States.

Coal Industry

Mining

The development of new coal-mining capacity, both as to its geographical location and production method, is greatly affected by Federal regulations. These factors, in turn, help determine the capital cost per ton of new capacity.

Although capital costs vary considerably, \$50 per ton of annual capacity for new deep mines, \$15 per ton for new western and \$20 per ton for new eastern surface mines were used by the Bank to forecast total capital costs. In addition, a typical preparation plant for washing, sizing and blending of raw coal is assumed to average \$11 per ton of annual capacity. It is anticipated that preparation plants will be required for virtually all new eastern mines as well as for a significant share of the new western mines.

Because of the surge of western coal development in the last few years, capital expenditures have been high. However, due to the continued softness of the coal market and the surplus capacity now available, it is expected that capital investment will dip to a low of \$1.7 billion by 1981 from \$2.1 billion in 1979. Thereafter expenditures are projected to rise to \$2.5 billion in 1985 and to \$3.2 billion in 1990, as the coal industry expands to meet the rising requirements of the electric utility, manufacturing and synfuel industries.

Transportation

To provide the additional transportation capacity required for the incremental coal production projected during the coming decade, capital expenditures are forecast to reach \$2.2 billion in 1990 from \$1.4 billion in 1979. It is expected that railroads will continue their present role in moving more than two-thirds of coal production. The greater part of the rail expenditures will be for unit-trains, costing an average of \$6.5 million per train of 100 cars and four locomotives. The Bank forecasts cumulative expenditures of \$12.2 billion for new unit trains and other rail stock.

At the same time waterborne transportation needs will continue to expand in the coming decade and some coal-slurry pipelines, which are now held up by water-resource and right-of-way problems, will be built. Capital costs for these facilities are expected to amount to \$6.1 billion through 1990, bringing the total for coal transportation during the forecast period to \$18.3 billion.

Electric Utility Industry

Expenditures by the electric utility industry are projected to dip from about \$35.3 billion in 1979 to a low of \$30.2 billion in 1984. This corresponds to a decline rate of 3 percent per annum, which compares with a 10 percent growth rate during the five years preceding the 1973 embargo, and a 3 percent rate during the post-embargo period. After 1984 electric utility expenditures are forecast to rise again, increasing to \$39.9 billion by 1990, or by an average rate of nearly 5 percent per annum.

Generation

In projecting investment required for generating facilities, Bankers Trust Company modified published data on utility industry expansion to conform to its own forecast of electric power demand. Capacity additions by 1990 include 90,000 megawatts of nuclear power plants and 140,000 megawatts of coal-fired facilities. Consideration has been given to government efforts to spur conversion to coal and account has been taken of the more stringent Federal safety standards expected for nuclear plants.

Bankers Trust Company assumed average per-kilowatt capital costs of \$1,050 for nuclear power plants, \$830 for coal-fired plants with scrubbers and \$700 for those without. Based on these assumptions generation expenditures are projected to decline gradually from \$24.9 billion in 1979 to a low of \$21.2 billion by 1984, for several reasons: First, surplus generating capacity in some regions will lead to construction delays or cancellations. Second, utilities, suffering financial problems in a highly inflationary environment, will be reluctant to commit to any but very necessary expansion. Finally, in the early 1980s fewer nuclear power plants will be in the heavy phase of construction than in 1979.

Beginning in the middle 1980s, with reserve margins diminishing, scrubber expenditures rising and nuclear plant construction growing again, the decline in outlays will be reversed. The Bank forecasts them to rise to about \$28 billion in 1990, or by over 30 percent.

Transmission, Distribution and Related Facilities

In the early 1970s expenditures for transmission, distribution and related facilities accounted for over 60 percent of total utility expenditures, but by 1979 this percentage had declined to 30 percent. One reason for the decline was the slowdown in electric power growth, which reduced the need for new transmission lines and hookups. Meanwhile, despite the cancellation and delay of many projects, generating expenditures were soaring during this period. The utility industry was still in the process of switching from the construction of oil- and gas-fired facilities to coal-fired and nuclear power plants, which are

much more expensive. Also, environmental and safety standards during the 1973-79 period were becoming more stringent, raising generating capital costs considerably.

The shift out of oil- and gas-fired construction is now virtually complete, and safety and environmental restrictions are not anticipated to be severely tightened during the forecast period. Therefore, there is no reason to assume a further change in the non-generating share of total utility investment, which has been about 30 percent in recent years. Based on this expectation, the Bank projects expenditures for transmission, distribution and related facilities to dip from about \$10.4 billion in 1979 to \$9.0 billion in 1984 and then rise to \$11.9 billion by 1990.

Nuclear Fuel Cycle

Private-sector capital costs of producing fuel for nuclear power plants are projected as averaging \$3.7 billion annually during the forecast period, rising from an estimated \$1.9 billion in 1979 to \$5.1 billion in 1990. This includes the costs of mining and milling and fabricating fuel elements from the enriched uranium, but excludes the cost of enrichment which is performed in government-owned facilities.

In estimating fuel-cycle capital costs, it has been assumed that the cycle will remain "open" in the 1980s—that is, spent fuel will be stored as waste rather than be reprocessed to recover the residual energy content. The Bank believes uranium supplies will be adequate to sustain open-cycle operation during the 1980s.

Gas Utility Industry

Although capital investment by gas utilities in 1990 is forecast to be only 7 percent above the \$4.2 billion level of 1979, investment is projected as rising to \$11.9 billion in 1984. Thereafter expenditures are forecast to drop sharply to \$4.5 billion by 1986 and then hold at that level through 1990.

The spurt in the early part of the period principally reflects outlays for the \$23-billion Alaskan gas pipeline project, most of which is to be financed in the United States. During the same period, a total of \$4.3 billion will be spent on LNG carriers and terminal facilities in the United States.

Since the gas pipeline network in the contiguous 48 states is essentially complete, capital outlays for its expansion, maintenance and replacement are expected to hold relatively constant, falling within the \$3.6 billion range over the entire forecast period.

External Financing Requirements



To finance their capital investments, the energy industries rely heavily on the sale of stocks, bonds and commercial paper, and on loans from banks and other financial institutions. These industries as a whole have depended on such external financing for about 35 percent of their capital needs, with reliance varying significantly by industry. Since the early 1970s external financing for the investor-owned sector of the electric utility industry has ranged from 55 to 70 percent of total expenditures, while for the oil industry it has ranged from 10 to 25 percent.

Whether the energy industries' overall external financing ratio of 35 percent will change in the coming decade is highly uncertain. On the one hand, the relative stagnation of the electric utility industry, which is the most dependent on the credit and capital markets, will tend to lessen the overall external requirements of the energy industries. On the other hand, such massive capital undertakings as the establishment of a synthetic fuels industry and the construction of the Alaskan gas pipeline will be heavily funded in the financial markets.

Perhaps most importantly, what happens in the fast-growing oil and gas sector will affect the energy industries overall external financing ratio. For the moment because of the combination of decontrol and soaring world oil prices, the oil and gas industry's cash flow position is strong, and consequently its external financing ratio is down from the levels of just a few years ago. However, expenditures for the oil and gas industry are expected to increase significantly between now and 1990. As they do, the industry's reliance on outside financing could grow quite sharply, both as a proportion of its total capital expenditures and in absolute dollars.

Because of these uncertainties and others, such as market perception of industry risk, government policies affecting cash flows and future interest rate levels, any forecast of the energy industries external financing ratio over an eleven-year period must be somewhat subjective. The Bank believes that the changing factors will tend to be offsetting and the external financing ratio should remain close to its historic level of 35 percent. At this level, the energy industries would require \$390 billion of external financing for the full period 1980-1990 in 1979 dollars. If the majority of variables were to combine adversely and force external financing to an extreme level of 45 percent, then the necessary financing would rise to \$500 billion. In current dollars the external financing requirements of the energy industries would range from \$680 to \$870 billion for the forecast period.

The relationship of these figures to the U.S. business investment sector and the credit and capital markets is examined later.

Economic Background



Having analyzed the prospects for U.S. energy demand during the 1980s and the investment and financing required for expanding domestic energy supply, this section will discuss the economic environment in which the energy industries will operate. Included are the Bank's projections of the U.S. gross national product, business investment and credit and capital markets.

Until now dollar figures have been given in constant-1979 dollars, which permits meaningful comparison of investment expenditures over long periods of time. However, in the real world expenditures are given in current dollars. Annual reports record expenditures according to actual dollars spent. Company and Federal budget forecasts are given in current dollars, as are government statistics on the financial markets and U.S. investment. Therefore to permit comparison of figures used in this analysis with those of the real world, all dollar numbers throughout the remainder of the study will be given in current dollars unless otherwise stated.

Economic Growth and Inflation

During the decade of the 1980s, real economic growth is forecast to average about 2.75 percent annually after recovering from the 1980 recession. This is about in line with the pace of the 1970s, which included the worst recession since the 1930s, but is far below the 4 percent growth rate of the 1960s. Several factors are expected to contribute to this relatively sluggish growth:

- 1) a continuation of rapidly rising energy costs;
- 2) an intractable, basic inflation rate that will also work to retard economic expansion;
- 3) a reduction in growth of the labor force due to a decline in the 14-24 year population group and a slowing in the rate of women entering the labor force; and
- 4) a continuation of limited productivity gains.

It is assumed that the rate of inflation, using the GNP deflator as the measure, will be brought down from the 10 percent annual rate of 1980 to 8 percent by 1982. However, because of rising energy and labor costs, low productivity gains, and with still strong social and political pressures for continued high government spending, the annual rate is projected to remain at 8 percent through the rest of the decade.

Nonresidential Fixed Investment

During the decade of the 1970s, business investment increased at about the same rate as the overall economy—9.8 percent annually in current dollars. During this period, the business investment share of GNP averaged 10.2 percent.

Bankers Trust Company believes that business investment during the 1980s will grow somewhat faster than the economy in general. Business as a whole will be under pressure to improve efficiency and expand productive capacity. These efforts will be abetted by new government incentives aimed at spurring plant and equipment spending. Moreover, expenditures for energy development will be rising sharply. Particularly significant will be the need for business to adapt to the high-cost, supply-constrained energy environment of the 1980s. These investments will be extensive and affect many different industries. They include expenditures for:

- 1) retrofitting and replacement of industrial facilities for increased fuel efficiency;
- 2) conversion of oil- and gas-fired plants to coal;
- 3) retooling by vehicle manufacturers to meet mandated fuel-economy standards;
- 4) expansion of public transportation;
- 5) significant growth in productive capacity to manufacture synfuel and solar equipment; and
- 6) meeting existing environmental regulations.

Because of all these factors, Bankers Trust Company projects total business investment to rise from an average 10.2 percent of GNP in the 1970s to an average 11.2 percent in the 1980s with the ratio at 11.7 percent by 1990. As a result, business outlays for new plant, equipment and other types of fixed capital are expected to increase from \$255 billion in 1979 to \$868 billion in 1990, or by almost 3½ times. (Table 12)

Credit and Capital Markets

Funds are raised in the credit and capital markets through a variety of instruments. They include corporate bonds, stocks, commercial paper, U.S. Government securities, state and local securities, mortgages, consumer credit and bank and finance company loans to business. Excluded are funds raised by financial intermediaries so that the total of these funds are the measure of the external financing required by the three major economic sectors: business, household and government.

Although the volume of these requirements is obviously closely related to the level of economic activity, additional factors contribute to the amount of borrowing and lending at any particular time. During the past 15 years, and especially until the mid-1970s, participants in the credit markets relied increasingly on external financing so that funds raised grew at an annual rate of 12.4 percent as against a 9.2 percent growth rate for GNP.

The optimism of the 1960s and early 1970s helped induce business to take on a heavy load of debt to expand operations. This became increasingly necessary as inflation rendered depreciation allowances inadequate to cover replacement costs. However, the credit crunch of

Table 12

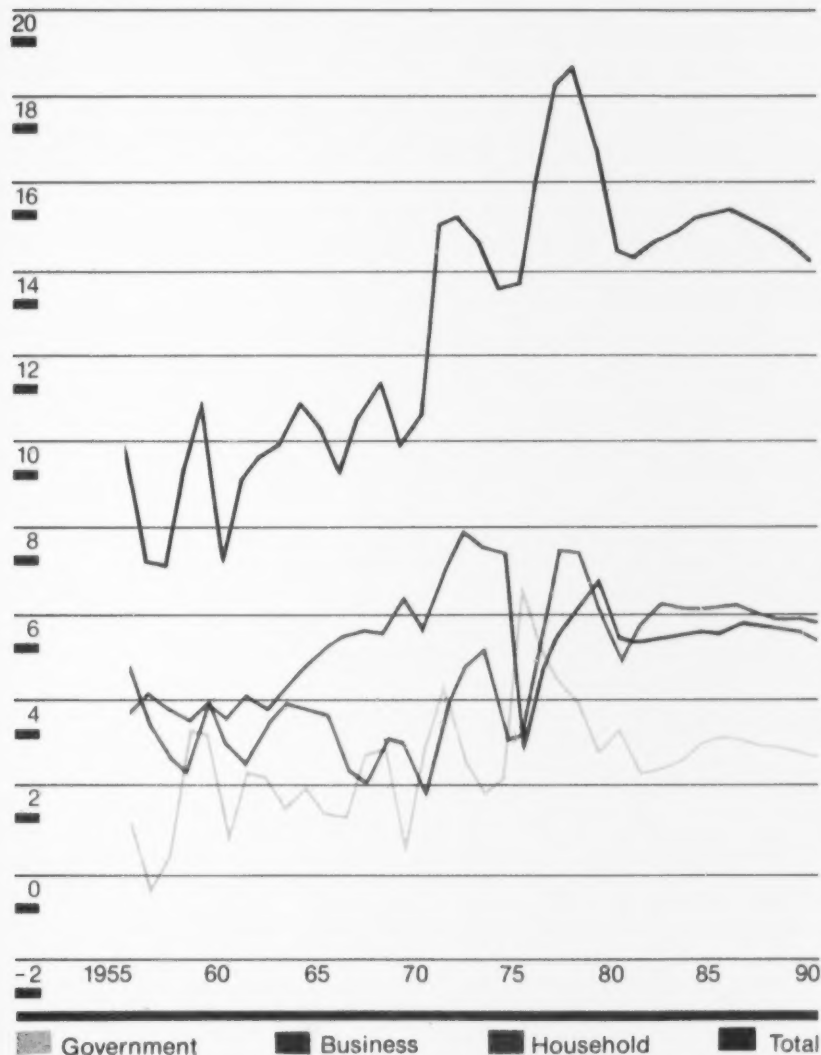
Economic Projections¹ (Billions of Current Dollars)

	Gross National Product	Nonresidential Fixed Investment	Total Credit & Capital Markets
1979	2369	255	393
1980	2603	275	369
1981	2888	306	408
1982	3218	347	470
1983	3570	396	525
1984	3964	442	601
1985	4400	492	671
1986	4880	549	750
1987	5416	615	810
1988	6008	689	890
1989	6670	775	980
1990	7397	868	1065

¹Source: Bankers Trust Company, Economics Group

Chart 5

Net Funds Raised by Major Nonfinancial Sectors as a Share of GNP



*Total includes government, household, business and foreign loans and securities.

1974 made business more careful about preserving debt-equity ratios, and although business borrowing in 1979 was well in excess of that of any other year, relative to GNP it was still below the record reached in 1973. (Chart 5)

During most of the 1970s, borrowing by households increased more rapidly than GNP. The growth in mortgage credit was especially rapid because of a combination of rising land costs, the sizable increase in the value of existing homes and their unusually high turnover rate as well as the increased use of mortgage credit for purposes other than housing. Also, the increased use of bank credit cards accentuated the cyclical expansion of consumer credit.

On the Federal level, growing budget deficits forced the Treasury to increase borrowing faster than the GNP through 1975. Although deficits declined thereafter, Treasury borrowings relative to GNP were higher than in the 1960s. State and local financing, on the other hand, has increased roughly at the same pace as the economy. As a result total Government financing, as a share of GNP, increased from 1.7 percent in the 1960s to 3.6 percent in the 1970s.

Altogether, the volume of funds raised in the credit and capital markets reached a high of 18.6 percent of GNP in 1978, up from peak levels of under 11 percent in the 1950s and early 1960s. However, the ratio is projected to fall back to within a 14 to 15 percent range in the 1980s, since none of the major sectors is expected to reach the peak financing relative to GNP recorded in the 1970s.

Business external financing, relative to GNP, is projected to remain essentially unchanged, about 5½ percent through 1990, even though the business investment share of GNP will be rising. Business cash flow on the whole should improve in the coming years, in part because of an expected change in government tax policies. Nevertheless, a major share of investment outlays still will have to be raised through external financing.

Roughly one-third of these funds will probably be raised in the corporate bond market. In addition, the equity market will probably be more hospitable so that more companies will be taking this financing route. In the short-term area, large corporations with top credit ratings will be relying heavily on the commercial paper market, and many will continue to tap the Eurodollar and Eurocurrency markets. Additionally, finance companies have become aggressive in packaging financing deals and lending funds to business. But the main source of short-term business borrowing will remain the commercial banks.

Financing by the household sector is likely to account for a smaller share of GNP in the forecast period, mainly because mortgage financing will follow the trend of home construction more closely than in the past few years when mortgage credit was viewed as a bargain. Soaring energy and construction costs will encourage or force more families into smaller homes, cluster housing or apartment dwellings. In the latter half of the 1980s, housing requirements will probably be growing less rapidly because of demographic factors. Thus it is anticipated that although home construction will be growing in line with GNP, home mortgage financing will decline as a percent of GNP from that of the late 1970s. Including consumer installment credit, the household financing share will average about 6 percent during the forecast period, a little less than one percentage point below that of recent years.

As for the government sector, real defense outlays are expected to be rising for much, if not all, of the 1980s, while inflation will be pushing up nonmilitary spending, especially transfer payments. Congress will likely provide periodic tax relief to limit the personal and business income tax burdens, thus holding down the growth of receipts. Furthermore, the expanding needs of the various off-budget government agencies are expected to require additional financing through the Treasury. Consequently, government financing requirements are expected to continue to be sizable.

Nevertheless, relative to GNP, government deficits will fall below the extraordinary share of the mid-1970s. The political and economic pressures are such that additional expenditures for nonmilitary purposes probably will be heavily resisted in the 1980s. Therefore, while Federal budget deficits are projected to remain large, relative to GNP they are projected to fall short of the levels of the mid-1970s. Meanwhile, no significant change is expected for state and local financing, which has hovered near one percent of GNP since the 1960s. Overall, Bankers Trust Company expects total government financing as a share of GNP to be about 2.8 percent in the 1980s, down from an average of 3.6 percent in the 1970s.

Based on the foregoing analysis, Bankers Trust Company projects net funds raised in the credit and capital markets to increase from \$393 billion in 1979 to \$1,065 billion in 1990.

Impact of Energy Expenditures



Energy Share of GNP

In recent years energy expenditures, as a share of GNP, have been slowly rising. Between 1973 and 1979 the share increased from 2.6 percent to 3.2 percent. By 1990 it is anticipated to rise to 3.8 percent.

These figures exclude lease bonus payments which, as transfer payments, are not part of GNP. Thus, although energy expenditures will undoubtedly be very large in absolute dollars, as a proportion of GNP they will continue as a modest share of GNP. Still, energy investment in 1990 is projected to be \$90 billion greater than if its share of GNP had remained at the 1973 level. Such an amount, equaling about one-third of all energy expenditures in 1990, does represent a significant shift in economic resources in the investment sector.

Energy Share of Business Investment

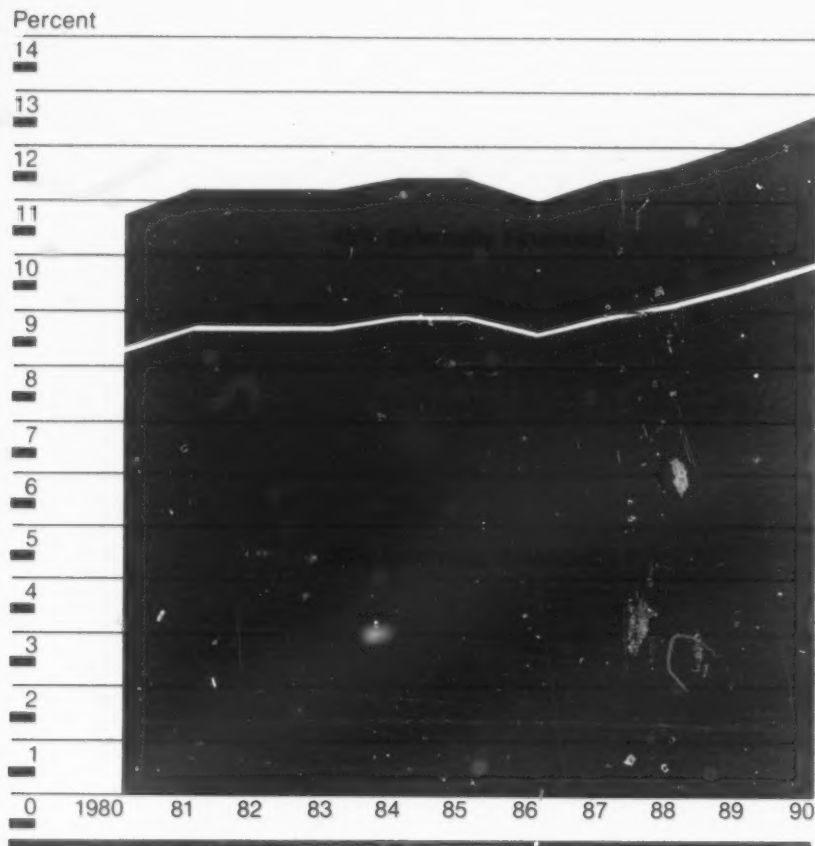
Since the oil embargo the energy industries have claimed an increasing share of total U.S. business investment, up from 25 percent in 1973 to almost 30 percent in 1979. The Bankers Trust Company forecast indicates that this share will average about 32 percent during the 1980s. Among the energy sectors, the biggest increase in share will be for oil and gas drilling and alternative fuels. Excluding lease bonus payments, exploration and development outlays will rise to almost 14 percent by 1990, up from 10 percent in 1979 and only 7 percent in 1973. The alternative fuels industry is expected to rise from a near zero share in 1979 to 3 percent by 1990, and will be increasing sharply thereafter. Meanwhile, the electric utility industry's share, which has averaged about 14 percent in recent years, is expected to slide to about 11 percent in the middle 1980s and then stabilize at that level for the remainder of the forecast period.

With the energy industries' overall share of business investment expected to rise by only 2 percentage points in the 1980s, Bankers Trust Company concludes that the resources of other industries will not be thereby drained to the point that economic growth need be imperiled. This optimistic conclusion, however, is based upon the premise stated earlier that the nation's business investment share of GNP will climb from the 10.2 percent average of the 1970s to 11.7 percent by 1990. Should this not happen, investment would be inadequate to sustain the economic growth projected in this study.

For example, a 10.2 percent share of GNP in 1990 would result in \$314 billion of total business investment in 1979 dollars, of which \$120 billion would be for the energy industries. This leaves \$194 billion for all the non-energy industries. Since non-energy expenditures amounted to \$179 billion in 1979, such expenditures would be growing at only 0.7 percent per annum in the forecast period. This would be too low to

Chart 6

Energy Industries' Share of Credit and Capital Markets



propel GNP growth at the projected post-recession 2.75 percent per annum rate, especially since a growing proportion of investments in the 1980s will be needed to adapt to a changing energy environment.

Clearly, the business investment share of GNP will have to grow to accommodate both the energy and non-energy investment requirements of a growing economy. To the extent necessary, economic resources—labor, capital and materials—will probably flow naturally to the business sector from other sectors of the economy. Business has historically enjoyed a priority in the credit and capital markets because it has had the ability to outbid other sectors of the economy and offer investors more attractive opportunities than elsewhere.

However, other shifts will occur too. The personal savings rate, which by the end of 1979 had dropped to 3.5 percent, will increase. By saving more, individuals will consume less and thus free up funds and resources to be used in the business sector of the economy. While the gradual removal of interest rate ceilings may increase the savings rate somewhat, tax incentives for business investment and liberalized depreciation schedules are essential to provide business with the needed funds.

Most importantly, the high inflation rate prevailing during the early part of 1980 will have to be lowered. Both personal and business savings are discouraged by inflation. During periods of high inflation individuals tend to follow a "buy now" psychology, which lowers the saving rate. At the same time, real business profits decline relative to investment requirements. Although it is recognized that certain exogenous factors, such as oil price increases, have contributed to inflation in the past, much of the fault can be attributed to the Federal government: Budget deficits have been too large and the money supply has grown too rapidly. Thus, in the future if the United States is to allow for more investment, it is essential for the government to reduce budget deficits and curb monetary growth. Not only will this help reduce inflation, but it will also increase the supply of funds available to the business sector for productive investment.

Energy Share of Credit and Capital Markets

If the energy industries continue to externally finance about 35 percent of their total capital requirements, then their share of the credit and capital markets is projected to rise from 7 percent in recent years to roughly 9 percent in the early 1980s and 10 percent by 1990. If on the other hand, their external financing proportion were to rise to 45 percent, as assumed in the high case, then their share of the capital market would rise to 11 percent by the early 1980s and to over 12 percent by 1990. (Chart 6)

Even in the high case, however, Bankers Trust Company believes that no undue burden would be imposed on the credit and capital markets. In the past these markets have had to adjust to far greater shifts over much shorter periods of time.

For instance, in the two-year period from 1975 to 1977, home mortgage financing increased from \$41 billion, or less than 20 percent of the capital market, to \$100 billion, or 29 percent. Similarly, U.S. government financing skyrocketed from \$12 billion in 1974 to \$86 billion the following year, or from 6 percent of the market to 41 percent. And business financing almost quadrupled from the recession-induced low of \$44 billion in 1975 to \$162 billion in 1979, as its share of the capital market jumped from 21 percent to 41 percent. Although these were largely cyclical shifts, the Bank believes that over the next ten years the growing credit and capital markets should be able to adjust to the modest reallocation of resources needed to meet the projected requirements of the energy industries, without constraining the concurrent growth of non-energy business.



Conclusions

The wise development and use of energy during the 1980s will be crucial for the United States. As domestic oil production continues to decline through at least the first half of the 1980s, foreign oil supplies will remain limited. Such abundant domestic sources of energy as coal and nuclear power will have to expand significantly to meet the growing energy needs of the country, but their contribution will be held below their potential by such considerations as worker safety, environmental pollution and bureaucratic delays. Surprisingly, natural gas, which was in short supply for much of the 1970s, is forecast to be relatively abundant, with Alaskan gas and a rise in imports more than offsetting a decline in lower 48 production.

The alternative fuels, upon which so much government emphasis has recently been placed, will yield only small amounts in the 1980s. This is an infant industry with many hurdles to overcome before beginning to supply significant amounts of oil and gas substitutes in the 1990s.

However, energy supply is only part of the picture. Demand must also be considered. A slow-growing economy will help hold down energy consumption, but even more important will be the continuing improvements in efficiency. The transportation sector will show an actual decline in demand as more efficient vehicles replace existing wasteful ones. Households will use considerably less energy for heating homes and operating appliances, while industry will consume less energy for each unit of output.

Of the available fuels, demand for coal and electricity will show the most rapid growth. Both will be perceived as secure and reliable, and in addition electricity prices will be rising less rapidly than those of competitive fuels. Supply limitations and high prices will be the main reasons behind the decline in petroleum consumption, while natural gas consumption by 1990 will be up slightly, after declining through the middle 1980s.

The benefits of improved energy efficiencies and greater development of domestic resources will become increasingly evident towards the end of the 1980s, when imports will finally begin to fall. National security will be enhanced, as imported oil's share of U.S. energy consumption slumps from 21 percent in 1979 to 13 percent in 1990. Constant dollar payments for oil will continue to increase through the middle 1980s, but by 1990, despite real oil price increases, they will be no higher than expected for 1980.

None of this, however, will come cheaply. It will be realized only as a result of an intensified development effort for all types of fuels and a massive conservation and fuel-conversion program by businesses and private individuals in response to higher energy prices and government mandates. Consumers will have to recognize that to get sufficient supplies of energy they will have to pay true costs, and that subsidized prices, while pleasant enough in the short term, lead to energy wastefulness and shortages in the long term.

The energy industries will spend \$1.1 trillion over the 1980-1990 period in 1979 dollars. Many untold billions will also be required for the non-energy industries to adapt to a changing energy environment. Yet the economy should be able to absorb these expenditures with minimal economic dislocation.

Energy financing will not prove disruptive to the credit and capital markets, even if the energy industries become more reliant on outside sources of funds. Traditionally, energy financing has accounted for a rather small share of the total financial markets. Although this share will be growing, it will remain comparatively small and should not cause a serious reallocation problem.

However, the share of the economy devoted to business investment will have to increase to accommodate both the needs of the energy industries and the rest of business. Some of the needed economic resources will probably flow naturally from the government sector to the business sector. Also, high home-ownership costs will be pushing families away from single-family homes and demographic factors will lower the growth in housing requirements later in the 1980s. The economic resources released from these sectors over the next decade will be available for business investment.

Still other fundamental shifts and adjustments will also have to occur. Personal savings will have to increase, with a resulting decrease in personal consumption so as to free funds and resources for the business sector of the economy. Tax incentives to encourage business investment and liberalized depreciation schedules also will be necessary. Most important, inflation will have to be curbed if adequate productive investment is to occur.

In short, the 1980s promise to be a decade of transition for the United States—a transition from excessive dependence on a high-priced, increasingly unreliable supply of foreign oil to greater reliance upon domestic, more secure energy sources. The transition will not come easily, nor will it be completed by the end of the decade. Despite the magnitude of the \$1.1 trillion, Bankers Trust Company believes that such expenditure need not stand in the way of economic growth in the 1980s.



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